National Aeronautics and Space Administration

NASA Langley's
## Adaptive Refinement Tools

Software for real-time refinement of unstructured grids in numerical analysis

NASA Langley engineers have developed a new software package for more facile computational fluid dynamics. The software's fast user run time, robustness, and efficiency have enabled its extensive use in space shuttle modeling. Adaptive Refinement Tool (ART) permits the computational modeling of flow, including jet or rocket plumes, wakes, and shocks via unstructured tetrahedral grids. Commercially available software packages often struggle to sufficiently and quickly model such complex examples of flow. ART also allows cells to be divided into two, four, or eight cells as compared to traditional software, which allows cell division only in units of eight. This is advantageous as it allows the user to control cell division more succinctly. ART executes command via colloquial English and has built-in internal statistical programming that increases its ease of use. ART allows the user the choice of alternate variables such as temperature or pressure at will, which facilitates modeling unusual or unlikely occurrences.

Benefits

- Very fast run time (minutes as compared to hours for similar software)
- Use of tetrahedrals as opposed to commonly used rectangles, which increases flexibility
- Ability to divide cells in multiples of two, four, or eight
- Ability to place flow functions in the inventive code for instant access by user
- Command codes in colloquial English, allowing greatest ease of use
- Variable adaptation, permitting modeling of unusual scenarios

partnership opportunity

The Technology Gateway
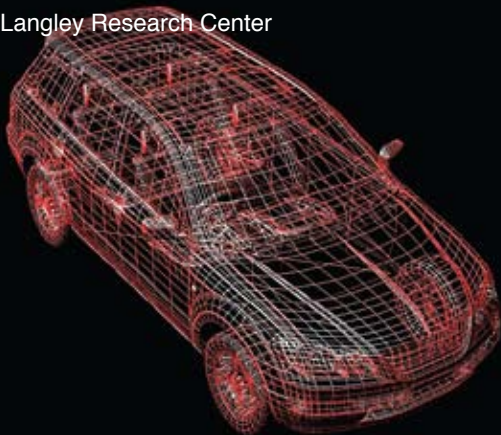
Applications

The ART software package is useful for any industry modeling flow, including:

- Aerospace
- Aviation
- Automotive

The Technology

NASA's robust and highly user-friendly ART software package was developed in response to an internal need to model complicated flow models. Commercially available software did not allow NASA the flexibility to model the complexities associated with spacecraft reentry or to model unusual and unforeseen scenarios. With the end goal being flexibility, NASA based ART on standard Fortran-90 language and used tetrahedrals as opposed to rectangles in the grid design. NASA also chose an edge-based algorithm so that the run time for running simulations is linearly scalable to the number of cells in the grid. ART is unique in that h-refinement software usually allows cell division in multiples of eight, and ART has been specifically designed to permit the user to divide cells in multiples of two, four, or eight. Furthermore, for particularly large cells, ART will allow the user to divide the specific cell multiple times by repeated application of the adaptive process. Unlike commercial software packages, ART allows the user to alter the flow function values at will, which facilitates the modeling for several scenarios.

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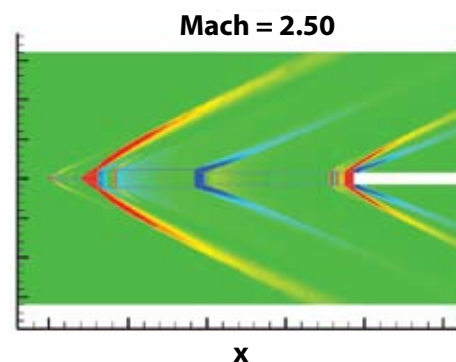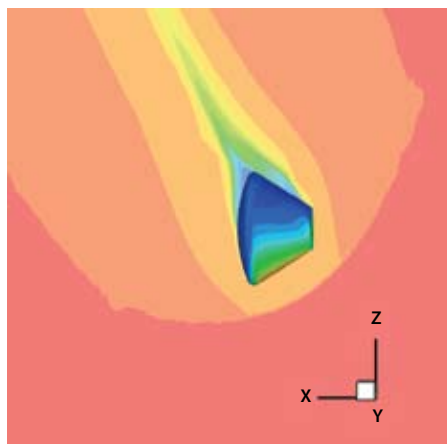
ART model of the Apollo spacecraft reentry and a shockwave, respectively

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

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